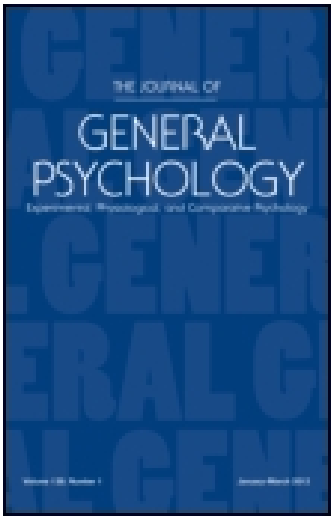

The Journal of General Psychology

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/vgen20

The Rôle of the Isolated Conditioned Stimulus in the Integrated Response Pattern, and the Relation of Pattern Changes to Psychopathology

W. Horsley Gantt [a]

[a] The Pavlovian Laboratory of the Phipps Psychiatric Clinic , Johns Hopkins University

Published online: 04 Nov 2012.

To cite this article: W. Horsley Gantt (1940) The Rôle of the Isolated Conditioned Stimulus in the Integrated Response Pattern, and the Relation of Pattern Changes to Psychopathology, The Journal of General Psychology, 23:1, 3-16, DOI: 10.1080/00221309.1940.10544063

To link to this article: http://dx.doi.org/10.1080/00221309.1940.10544063

The Journal of General Psychology, 1940, **23**, 3-16.

THE RÔLE OF THE ISOLATED CONDITIONED STIMULUS IN THE INTEGRATED RESPONSE PATTERN, AND THE RELATION OF PATTERN CHANGES TO PSYCHOPATHOLOGY*

The Pavlovian Laboratory of the Phipps Psychiatric Clinic, Johns Hopkins University

W. Horsley Gantt, M.D.

A. Introduction

An interaction between conditioned reflexes of the positive and negative types was recognized by Pavlov (6) and explained by the law of induction—a term borrowed from the neurology of Hering and Sherrington. The Gestalt psychologists, on the other hand, minimizing the reactions to the individual stimuli, emphasize adaptation to the pattern. The following experiments were designed to show when, in the conditioned reflex procedure, the effect of the position of the stimulus dominates and when its isolated action is most important.

The arrangement adopted here is one of the simplest possible—the regular alternation of two stimuli of different intensities. After many repetitions of the stimuli in the order *strong-weak-strong-weak* it was found that when one of the stimuli was repeated alone throughout the experiment, e.g., *strong-strong-strong-strong,* its value was somewhat dependent upon the relation of its position to the previously established order.

B. Experimental Data

Four dogs were used in these experiments. The two stimuli employed were a bubbling sound (*Bu*) accompanied by one unit of food and a metronome of 20 beats per minute (*M*20) accompanied by three to six units of food. In the other two dogs, in order to rule out the effect of any difference *per se* between *Bu* and *M*20, *Bu* was given with six units and *M*20 with one unit. All of the animals established conditioned reflexes of different intensity to the two stimuli determined by the amount of food used in the

*Received in the Editorial Office on March 18, 1939.

reënforcement of each, although the ratio of the intensities of the conditioned reflexes was much closer to unity than was the ratio of the amounts of food. The data of these experiments is to be discussed more fully in another paper dealing with the effect of the amount of the food on the intensity of the conditioned and unconditioned reflexes (1, 2).

In the training of *Lady,* an active, aggressive female bulldog aged two years, October 28, 1931, from the very first an alternation of *M*20 and *Bu* reënforced by 12 gms. and 2 gms. of food respectively was used.

*M*20 produced a larger conditioned secretion than *Bu,* i.e., the 1st, 3rd, 5th, 7th stimuli are stronger than the 2nd, 4th, 6th, 8th. After 42 seances of this routine (October 28, 1931 to January 22,

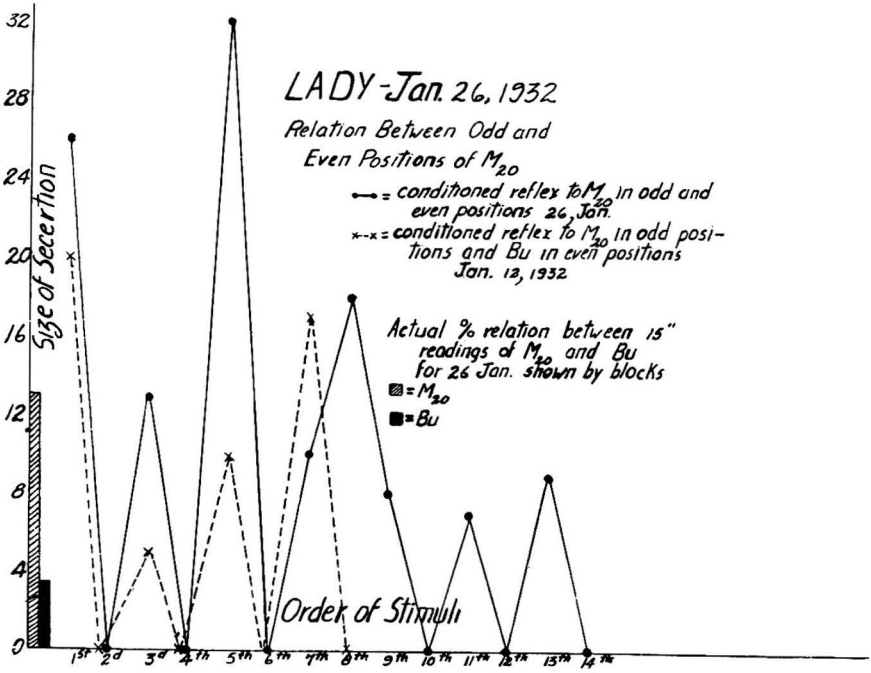

FIGURE 1

LADY

Effect of Position on a Conditioned Reflex: Relation between Odd and Even Positions of *M*20.

Ordinate = size of secretion.
Abscissa = order of stimulus.

TABLE 1

Protocol 1, Lady, January 26, 1932

Order stimuli interval	Time	*C.* Signal	No. repetitions	Latent period Secretory	Latent period Motor	Size *CR* (scale divisions)	Unc. S. (Amt. fd.)
1	15:17	*M*20	147	3	3	26 (5″)	18 gms.
2	15:21	*M*20	148	–	4	0 (6″)	18 gms.
3	15:25	*M*20	149	3	3	20 (6″)	18 gms.
4	15:32	*M*20	150	–	4	0 (5″)	18 gms.
5	15:37	*M*20	151	4	3	38 (5″)	18 gms.
						284 = 1 min.	
6	15:43	*Bu*	156	10	4	0 (5″)	3 gms.
						63 = 1 min.	
7	15:48	*M*20	152	4	3	10 (5″)	18 gms.
8	15:52	*M*20	153	5	–	25 (6″)	18 gms.
9	15:59	*M*20	154	4	3	8 (5″)	18 gms.
10	16:03	*M*20	155	–	5	0 (5″)	18 gms.
11	16:07	*M*20	156	5	–	7 (5″)	18 gms.
12	16:11	*M*20	157	–	–	0 (6″)	18 gms.
14	16:19	*M*20	159	–	3	9 (5″)	18 gms.
13	16:15	*M*20	158	4.5	2	0 (5″)	18 gms.

1932) an average value of 41 for *Bu* and 197 for *M*20 (60″ readings) was obtained, i.e., a ratio of 21/100.

On January 26 when the larger stimulus *M*20 was used alone there was a regular rise and fall of the conditioned secretions so that every alternate one was large just as if we had been using the original alternation. (See Table 1 and Figure 1.)

1. *Protocol 1*

The routine alternation was not disturbed again until the 16th of May, 1932, when on using *M*20 alone there was for the conditioned reflexes to *M*20 in the 1st, 3rd. 5th, and 7th positions an average of 54, and for the conditioned reflexes to *M*20 in the 2nd, 4th, 6th, 8th positions (positions formerly occupied by *Bu*) an average of 39 (ratio 72%). The actual ratio of *M*20 to *Bu* as tested on that day was 55 to 30 (ratio 54%). On the 27th of May there was an average of 41 for the seven odd numbered stimuli and 28 and five even numbered stimuli (ratio 68%); on the 7th of June an average of 91 for six odd numbered stimuli and 81 for four even numbered stimuli (ratio 89%). In the intervals between the days mentioned the dog was run on the usual schedule of *M*20 alternating with *Bu*.

Two other dogs, *Billy* and *Blue,* were trained in a way similar to *Lady* with certain variations to be mentioned. In these dogs *Bu* was reënforced by the larger amount of food and *M*20 by the smaller, the reverse of the reënforcement in *Lady,* to counteract the effect of a difference in strength resulting from the nature of the signals; for Pavlov has shown that different signals vary greatly in the intensity of the conditioned reflexes they evoke. Thus an auditory signal produces a larger conditioned reflex than a visual, a visual larger than a tactile, and a strong stimulus a larger reflex than the same stimulus when weaker (3, 4).

Blue (a young, male collie, timid, friendly, wt. 18 kgms.) was first used in the camera silenta on 27th of January, 1931. *Bu* was given alternately with *M*20, *Bu* being accompanied with 20 gm. and *M*20 with 2 gm. food until the 13th of May; the ratio of the conditioned reflexes being *M*20/*Bu* = 77 per cent. The dog was given a rest till 22nd of October, 1931. Then was begun a repetition of *Bu* alone in the entire experiment, without the usual alterna-

tion with *M*20. On 22nd of October the average of *Bu* when occurring as the 3rd, 5th, 7th position was 182; in the 2nd, 4th, 6th positions *Bu* averaged 143 (ratio 78%). Five experiments repeating *Bu* throughout were done between 27th of October and 6th of November, the odd numbered positions of *Bu* averaging 147, the even numbered 115 (ratio 78%).

Beginning with 14th of December, 1931, the order of the experiment was changed from the simple alternation of *Bu-M*20-*Bu-M*20-. . . to an alternation by pairs, thus *Bu-Bu-M*20-*M*20-*Bu-Bu-M*20-*M*20-. . . . On 25th of January, 1932, *M*20 used throughout the experiment without *Bu* gave an average of 38 for the odd numbered positions and 31 for the even numbered (ratio 81%). On 26th of January the other stimulus *M*20 repeated alone throughout the experiment gave an average of 53 and 43 respectively for the odd and even numbered positions (ratio 81%),[1] whereas the actual ratio on that date between *Bu* and *M*20 was 62 per cent (60″ readings). There was no adaptation at this time, however, to the arrangement in pairs, for the odd numbered *pairs* of positions were less instead of more than the even numbered (31 compared to 39).

Alternation by pairs of *Bu* and *M*20 was continued until May 11, 1932 (with interspersed alcohol experiments irrelevant to these), when *Bu* was tried throughout, giving an average of 110 for the odd numbered positions and 98 for the even (ratio of 89%). There was still no adaptation to the routine of alternation by pairs which had been used since 14th of December, 1931; the odd numbered pairs averaged 210, the even numbered 205. On the 13th of May *M*20, the smaller stimulus, given throughout the experiment showed a uniform value for the various positions—167 and 165 respectively for the odd and even *pairs,* and 86 and 82 for the odd and even numbered *single* stimuli.

Experimentation was begun on *Billy* (an American bull terrier, wt. 15 kgms., age about 3 years) on March 26, 1931, *Bu* and *M*20 being used alternately reënforced with 18 gms. and 3 gms. of food respectively. Adaptation to the signals for the two amounts of food was soon elaborated so that on 19th of May, 1931, after 34 experimental days, 155 was recorded for *Bu* and 48 for *M*20 (15″ readings), a ratio of 32 per cent. Testing *Bu* in the various posi-

[1]These readings were for 5″ whereas the previously elicited ones were for 15″.

tions on May 25, the odd numbered positions of *Bu* gave 218, the even numbered 189, a ratio of 86 per cent (30″ readings).

On December 1, 1931, on the 61st experimental day, the alternation was changed from *Bu-M20-Bu-M20* . . . to an alternation by pairs, *Bu-Bu-M20-M20-* . . . until January 19, 1932, after which the previous simple alternation was used until May 12 when the effect of the smaller stimulus, *M20*, was tried alone, giving 101 for five odd numbered stimuli, 86 for five even numbered, 222 for the odd pairs of stimuli, and 204 for the even pairs. On 24th of May, using one stimulus alone 144 and 115 respectively was obtained for the odd and even numbered positions of the stimulus, 252 and 270 respectively for the odd and even numbered pairs of positions. On 2nd of June, 1932, another repetition of *Bu* alone gives equality for all positions, viz., 117 and 116 respectively for the odd and even single positions, and 230 and 222 respectively for the odd and even pairs of positions. This equality was probably brought about by the frequent repetitions of experiments in which only a single stimulus was used (Figure 2).

In the intervening experiments the regular simple alternation of *Bu* and *M20* was employed; the ratio *M20/Bu* was 85 per cent for the 30″ readings. The simple alternation was continued from this period until January, 1933—for nearly two years since the animal was first started. Then the smaller stimulus, *M20*, was given throughout the experiment, 8 to 15 times per day from January 18, 1933, until April 4, 1933. At first the value of the even numbered positions of *M20* was about 70 per cent of the odd numbered positions, but the ratio of the values between even and odd positions rose to equality toward the end of the 3-month period. This is shown in Figure 2. The ratio of the secretory latent period is roughly parallel to the value of the secretion, as shown on the chart. Then the animal was rested until October 5, 1933, when a simple alternation was again used. On 9th of November, 1933, on trying *Bu* alone at 4-minute intervals, an average of 172 and 166 respectively was obtained for the odd and even numbered positions, and 347 and 331 respectively for the odd and even pairs of positions, showing that the effect of position had been almost abolished.

Dog 3 had a portion of the frontal, parietal, and occipital lobes removed on the left side in May, 1930. On 11th of February, 1932,

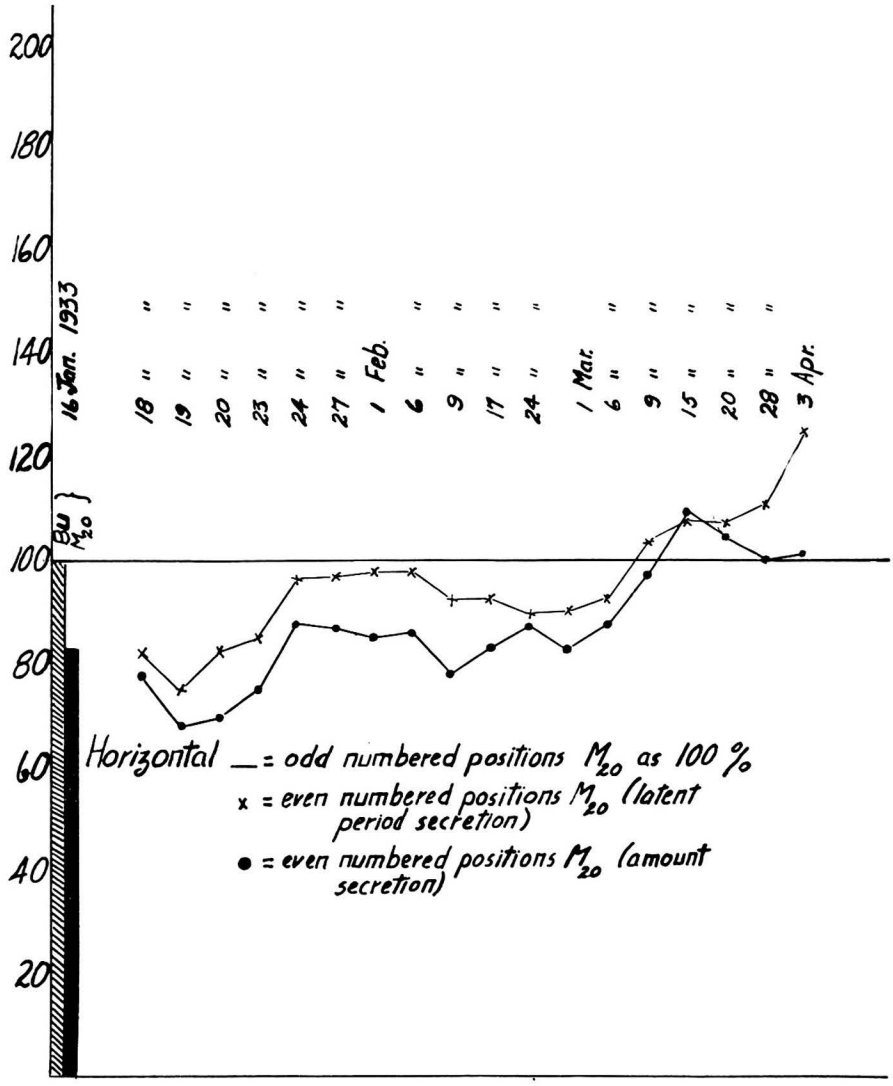

FIGURE 2

BILLY

Gradual Disappearance of the Effect of Position on the Size of Conditioned Reflex.

Ordinate = per cent of normal secretion to larger stimulus in odd numbered positions.

Abscissa = date.

experimentation with this animal was begun, using a simple alternation of *M*20 and *Bu* as in *Lady*. A differentiation between *M*20 and *Bu* was elaborated, though with difficulty; the conditioned reflexes were irregular and unstable. After 62 experimental days of this alternation the animal had not elaborated any differentiation according to position; he gave 12 and 14 respectively for the odd and even numbered positions on 12th of May, and no difference between the positions when tested with one stimulus on 11th, 24th, and 27th of May.

Adaptation to a more complicated sequence of stimuli was tested in a fifth dog, *Kompa,* used in the laboratory from 1929 to 1937. In February, 1931, he was started on a regular routine order of stimuli, viz., *B* (bell) *M*140 *Bu* *M*60 *L*60 (intermittent light) *M*140 *B*. They were all reënforced by a uniform amount of food (10 gms.) except *M*140, a negative stimulus, was given without food. Previously *M*140 had been positive, but it was extinquished and a fairly good differentiation obtained between it and the other positive stimuli. That an inhibitory effect resulted from *M*140 was evidenced by the small or zero secretion and the regular falling to sleep of the animal in 7 to 9″ after *M*140 began ticking (experiments with H. G. Wolff). The difference in the reactions to *M*140 (negative) and the positive signals used with *Kompa* was the difference between an excitatory (positive) and an inhibitory (negative) reaction, and much greater than the difference in the reactions of the other dogs which was a difference of intensity in two *positive* signals.

There was no adaptation whatever to position in *Kompa* as shown in the following tests. On May 19, 20, 23, 26 we ran one stimulus throughout the experiment at 4-minute intervals, obtaining an average for all the conditioned reflexes in all positions of 241, while the average of those coming in the 2nd and 6th positions, corresponding to the place occupied by the inhibitory stimulus *M*140, was practically the same as those in the other positions, viz., 246. On 9th of June, 1932, *Bu* was tried alone throughout the experiment; *M*60 alone on 10th of June and *L*60 alone on the 20th of June with the following results:

Average *Bu* all positions 188. for 2nd and 6th positions	172
Average *M*60 all positions 139 for 2nd and 6th positions	150
Average *L*60 all positions 64, for 2nd and 6th positions	57

Again on 10th and 11th of January, 1933, after an intervening repetition of the regular routine experiment, the effect of *B* used alone was tested:

Average of *B* used 14 times, all positions	238
Average of *B* used in 2nd and 6th positions	245

Besides the lack of adaptation to the positions of the negative stimulus, there was none as regards intensity of positive stimuli in this animal, shown by the following procedure. On 25th of November, 1933, the usual routine was altered by reduction of the unconditioned stimulus from 10 gms. to 1.0 gm. biscuit for all the signals except *L*60 (flashing light). This signal occupying the 5th and 11th positions in the ordinary routine was reënforced by two biscuits. For the last two weeks of January, 1934, there was an adaptation to intensity of the supporting unconditioned stimulus (ratio 1:8), shown by the ratio of the conditioned reflex between the other positive conditioned reflexes and *L*60, all measured for $10'' = \frac{86}{109} = 80$ per cent. On February 2 B_1 (bell) was used throughout the experiment: on the 6th of February *Bu* was used throughout, on the 19th of February *M*60 throughout, and on the 21st of February *L*60 throughout. The result of using B_1 throughout was:

Average 15 conditioned reflexes for 10″ = 33.
Average 2nd and 6th positions B_1 (corresponding to negative *M*140) = 33.
Average 5th and 11th positions B_1 (corresponding to former position of *L*60) = 17.

In the other experiments mentioned above the reactions in positions corresponding to the former inhibitory stimulus were perhaps slightly larger than the average, and the reactions to the positions occupied by *L*60 were slightly smaller than the average—the reverse of what might be expected. There was no consistent difference between the latent period, secretory and motor, for the various positions.

There is thus no adaptation in this animal, having a complex routine instead of a simple alternation, to the position of the stimulus. Neither was there adaptation in Dog 3, who had an impaired nervous system, even to the simple alternation.

C. Constitution and Ability for Adaptation

There is a decided correlation between the ability of the animals to form stable and well differentiated conditioned reflexes to individual stimuli and their ability to form an adaptation to the order of the stimuli. This ability is also correlated to the stability of the animals under various nervous stresses. To epitomize, *Billy* is the most stable animal, has not shown breakdowns as observed in his behavior nor as measured by fluctuations of the conditioned reflexes under identical circumstances (severe fighting and mistreatment) which have caused disturbances in *Kompa* and *Blue* with a chaotic relation of their conditioned reflexes lasting several days. *Lady,* in whom this adaptation to order and intensity was also well differentiated, was another very stable animal. *Blue* and *Kompa* were easily upset, judging by their behavior as well as by the corresponding chaotic relationships of their conditioned reflexes; they showed less ability to make differentiations than the other two dogs, and in the case of *Kompa* there was no adaptation to the order of the stimuli. *Kompa* also differentiated poorly between signals for different amounts of food. Dog 3 had a pathological (organic) deficit, differentiated poorly between intensities and made no adaptation to the order of the stimuli.

The elaboration of conditioned reflexes to a pattern explains also another phenomenon. Frequently the change in order of the experiment or of the stimuli results in severe nervous disturbances in dogs of a certain constitutional type, lasting perhaps for months. On the basis of a conflict between the conditioned reflexes to the old and new patterns this is no more difficult to understand than is the production of a neurosis by a conflict between opposite conditioned reflexes.

Pavlov found that introducing a new order of conditioned stimuli caused temporary disturbances in his animals, and furthermore that it was possible only in the animals with a "strong and equilibrated nervous system" to produce a dynamic stereotypy, i.e., a stable set of reactions to the system of stimuli; with the "strong and unbalanced, in the more or less weak, ill, exhausted, aged, it is another matter," the effects of the conditioned stimuli fluctuating chaotically (7).[2]

[2]Although the results reported by Pavlov in the chapter *"Dynamic Stereotypy"* of his *Cond. Reflexes & Psychiatry* (7) are similar to these, my

One is tempted to draw a parallel here. The human being, especially certain types, resists alterations in living conditions—a protective mechanism for the nervous system. Not only this, but changes for the individual, as in family crises, or for the mass of society as after revolutions, place a burden on the nervous system; for besides the disappointments and losses, the old patterns of stimuli are replaced by new ones (although the individual stimuli may remain), requiring a different order of reactions.

D. Induction and Adaptation

Kupalov in Pavlov's laboratory performed experiments somewhat similar to ours. He investigated the excitability of the animal after establishing an alternation of positive and negative stimuli at exactly 7-minute intervals. Soon after the application of the negative stimuli the positive reflexes were found to be normal; after three to four minutes, they diminished. But the negative reflexes following the positive stimuli at different intervals were normal. These fluctuations he explains as a phenomenon of induction:

> After each application of a conditioned stimulus there takes place a wavelike rhythmic change in the cortical excitability. These waves have a well pronounced character in the case of negative stimuli, but are barely visible after the positive. The changes of excitability are favorable for the formation of the given definite system of reflexes and are probably one of the factors in the synthesizing of the experiment into one integral complex (5).

My experiments differ somewhat from those of Kupalov. First he established a definite time reflex, which I avoided by not using any fixed interval between the signals but varying it from three to seven minutes. In his case the fluctuation of excitability may be ascribed to the time reflex which we know may be readily formed. In my experiments, a time reflex could hardly have been operative, but each stimulus whether positive or negative must have conditioned a certain excitability of the nervous system which was modified by the next stimulus, in spite of the fact that there was no time spacing. Secondly, Kupalov employed an alternation of positive

work was undertaken before Pavlov's was reported, and entirely independently of any knowledge of his experiments. The parallel results are strongly corroborative.

and negative signals while mine were two positive signals varying only in their intensity. Because the intensities of my signals were fairly close together (sometimes 2:3) my experiments present somewhat stronger evidence for an adaptation to a pattern than do those with an alternation of stimuli as far apart as positive and negative.

Furthermore, it would seem more difficult to apply the law of induction to our phenomena than to those of Kupalov. We have two choices here—if induction plays a rôle in the varying excitability of the cortex, as suggested by Kupalov, then we must extend the concept of induction to include these phenomena (both excitatory), or else revamp our notion of excitation and inhibition. Induction, originally employed by Hering and Sherrington, has been used by Pavlov for the cortex to designate a change in threshold or sensitiveness after a positive or negative stimulus in reference to a succeeding positive or negative stimulus. But my conditioned stimuli were strikingly alike—both being positive auditory food-conditioned stimuli, varying only in intensity. We must question the applicability of the law of induction to explain the adaptation to a sequence or pattern, or consider that the weak stimulus is a mixture of excitation and inhibition. Probably no satisfactory elemental explanation, such as is implied in the law of induction, can be given of this integrated adaptability of the organism to the whole environment. The fact of adaptation is nevertheless indisputable.

These experiments emphasize an adaptation to stimuli to which the law of induction as ordinarily stated by Pavlov is not applicable, although the experimental milieu resembles that of Kupalov's experiments in its regular rise and fall of excitability in the cortex.

Adaptation to the setting has for a long time been recognized empirically as well as theoretically though not explained, by the Pavlov school by the emphasis on a carefully controlled routine. Sometimes a seemingly slight variation in the order of the experiment may alter the results or even produce nervous disturbances, as Pavlov has often demonstrated. The fact that each single experiment that we perform on the animal may modify the reactions to the former order is another example of a major scientific dilemma—the process of testing the living organism leads to a different organism from the one we set out to examine. In daily life too there are many instances of the importance of order; the difficulty of counting

backwards is one, and all of us know how frequently a slight disturbance in the regular routine may seriously impair the efficiency for that day, and vice versa how powerful an aid is an established routine. One might well suppose that the more complex nervous system of the human can adapt to a more complicated order than can the simpler one of the dog. The rôle of integration versus a specific conditioned reflex has been recently shown in the human subject in the laboratory of Dashiell. A finger extension was conditioned in the forearm position of pronation which immediately became flexion in the position of supination.

Finally, the data of these experiments may bear on a topic with which our laboratory is now concerned—the relation of excitation to inhibition. Are these processes two distinct entities, or do they shade one into the other? The law of induction must be extended to include the interaction between two excitatory processes if it is to be applied here, or else we must consider the smaller conditioned reflex as inhibitory when compared to the larger.

E. Summary

In three normal dogs in which an alternation of two well differentiated strong and weak stimuli was employed it was found that the animal when given a single stimulus throughout the experiment reacted to *one and the same* stimulus by alternately strong and weak responses similarly to the sequence in which he had formerly reacted to the *two* separate stimuli. The reflex to a definite time interval was eliminated by varying the intervals between the strong and weak stimuli from three to seven minutes, though in the experiments for measuring the reactions to the repetitions of the single stimulus the interval was kept constant. The elaboration of a response to the sequence was nearly equal to the reaction to the individual stimuli themselves.

The adaptation to the pattern disappears more or less rapidly in different dogs when the old order is changed. In one of these dogs when the alternation was changed from a simple one to an alternation by pairs there was then some, however very slight, adaptation to the new and somewhat more complex sequence.

In two other dogs no adaptation to the same simple alternation in the one or to a regular routine in the other was evident. One of these dogs had undergone a partial cortical ablation, while the

other had a more complex series (+ — +++ — +) instead of strong-weak-strong-weak or strong-strong-weak-weak-strong-strong-weak-weak.

Apparently the ability to become conditioned to the series of the stimuli as a whole, i.e., to form an integrated conditioned response pattern, as measured by the salivary secretion, requires in the dog both an extremely simple pattern and a well balanced nervous system. The results of these experiments, as well as other considerations, clearly demonstrate that there is acting on the organism not only the individual stimulus in its own right but the context, the whole environmental set-up, in which it occurs. Whether the individual stimulus or the "configuration" to the whole pattern is the dominant factor in the reaction is determined by certain conditions of the experiment, as well as by the constitution of the animal.

REFERENCES

1. GANTT, W. H. The nervous secretion of saliva: Quantitative studies in the natural unconditioned reflex secretion of parotid saliva. *Amer. J. Physiol.*, 1937, **119**, 3.
2. ————. The nervous secretion of saliva: The relation of the conditioned reflex to the intensity of the unconditioned stimulus. *Proc. Amer. Physiol. Soc.*, 1938, **50**, 74.
3. KUPALOV, P. S., & GANTT, W. H. Relationship between strength of conditioned stimulus and size of resulting conditioned reflex. *Brain*, 1927, **50**, 44-52.
4. KUPALOV, P. S., LYMAN, R. S., & LUKOW, B. N. Relationship between intensity of tone-stimuli and size of resulting conditioned reflexes. *Brain*, 1931, **54**, 85-98.
5. KUPALOV, P. S. Reports from the Laboratory of Pavlov. Leningrad, 1933. (Vol. 5, pp. 446-449.)
6. PAVLOV, I. P. Lectures on Conditioned Reflexes. (Tr. W. Gantt.) New York: International Publishers, 1928. Pp. 333.
7. ————. Conditioned Reflexes & Psychiatry. New York: Inter. Pub., 1940.

The Pavlovian Laboratory
Phipps Psychiatric Clinic
The Johns Hopkins Hospital
Baltimore, Maryland